

In the Claims:

Cancel claims 1 to 61 and add claims 62 to 109 such that the claim set reads, as follows:

1. to 61. (Cancelled)

62. (newly added) An apparatus for cooling an electronic device, comprising:

a first fluid heat exchanger for transferring heat from a hot portion of the surface of said electronic device to a fluid, said first fluid heat exchanger including a body through which said fluid may be circulated;

a chiller for chilling said fluid, said chiller including a second fluid heat exchanger through which said fluid may be circulated, a thermoelectric cooler having a cool face and a warm face when connected to a power source, said thermoelectric cooler positioned with its cool face thermally coupled to said second fluid heat exchanger; a heat spreader plate a first face of which is thermally coupled to said warm face of the thermoelectric cooler; and a stack of spaced-apart heat conductive fins, each of which is thermally coupled to said heat spreader plate and extending away from the face of said heat spreader plate opposite to said first face of said heat spreader plate; and

a pump for circulating said fluid between said chiller and said first fluid heat exchanger.

63. (newly added) The apparatus as defined in claim 62, wherein said electronic device is a microprocessor comprising a die mounted in a package and the said hot portion is an exposed surface of the die.

64. (newly added) The apparatus as defined in claim 62, wherein a passage is provided within said body through which said fluid may be circulated, said passage comprising a series of chambers separated by constrictions.

65. (newly added) The apparatus as defined in claim 62, wherein the first face of the heat spreader plate defines a primary plane and the chiller is positioned such that air can move through the fins and in a direction substantially parallel to said primary plane.
66. (newly added) The apparatus as defined in claim 65 wherein the second fluid heat exchanger is formed as a thick plate and is positioned in a plane parallel to the primary plane.
67. (newly added) The apparatus as defined in claim 65, wherein the thermoelectric cooler is positioned in the chiller such that air can pass thereover when it moves through the chiller.
68. (newly added) The apparatus as defined in claim 62, further comprising a fan oriented to move air between said fins.
69. (newly added) The apparatus as defined in claim 62, further comprising a second heat spreader plate thermally coupled to said second fluid heat exchanger; and a second stack of spaced-apart heat conductive fins, the second stack thermally coupled to said second heat spreader plate.
70. (newly added) The apparatus as defined in claim 69, wherein the second heat spreader plate includes a face which face is positioned in a parallel plane to the primary plane of the first heat spreader plate.
71. (newly added) The apparatus as defined in claim 69, wherein the second fluid heat exchanger is positioned substantially centrally between the extended lengths of the stacks of fins.
72. (newly added) The apparatus as defined in claim 69, wherein all of said fins are substantially parallel to each other.

73. (newly added) The apparatus as defined in claim 72, further comprising a fan oriented to blow air between all of said fins in a direction substantially parallel to said heat spreader plates.

74. (newly added) The apparatus as defined in claim 73, further comprising a cylindrical housing, wherein said second fluid heat exchanger, said heat spreader plates, and said fin stacks are mounted inside said housing.

75. (newly added) The apparatus as defined in claim 74, wherein the lengths of said fins are selected so that each extends to an interior wall defining said housing.

76. (newly added) The apparatus as defined in claim 74 wherein the cylindrical housing defines a long axis and the second fluid heat exchanger is positioned along the long axis.

77. (newly added) The apparatus as defined in claim 76 positioned in a case for the electronic device, the case including an opening therethrough for access between its inner and outer surface and the cylindrical housing is positioned within the case open to the opening.

78. (newly added) The apparatus as defined in claim 75, wherein each fin stack includes a base plate and is extruded as a unitary structure.

79. (newly added) The apparatus as defined in claim 73, wherein each heat spreader plate and associated fin stack is extruded as a unitary structure.

80. (newly added) The apparatus as defined in claim 69, further comprising a second thermoelectric cooler having a cool face and a warm face when connected to a power source, the second thermoelectric cooler interposed between said second fluid heat exchanger and the second heat spreader plate so that its cool face is thermally coupled

to said second fluid heat exchanger and its warm face is thermally coupled to said second heat spreader plate.

81. (newly added) The apparatus as defined in claim 62 positioned in a case for the electronic device, the case including an opening therethrough for access between its inner and outer surface and the chiller is positioned adjacent the opening within the case.

82. (newly added) An apparatus for cooling an electronic device, comprising:

a first fluid heat exchanger for transferring heat from a hot portion of the surface of said electronic device to a fluid, said first fluid heat exchanger including a body through which said fluid may be circulated;

a chiller for chilling said fluid, said chiller including a second fluid heat exchanger through which said fluid may be circulated, a heat spreader plate a first face of which is thermally coupled to said second heat exchanger; and a stack of spaced-apart heat conductive fins, each of which is thermally coupled to said heat spreader plate and extending away from the face of said heat spreader plate opposite to said first face of said heat spreader plate, the first face of the heat spreader plate defining a primary plane and the chiller being positioned such that air can move through the fins and in a direction substantially parallel to said primary plane; and

a pump for circulating said fluid between said chiller and said first fluid heat exchanger.

83. (newly added) The apparatus as defined in claim 82, wherein the second fluid heat exchanger is formed as a thick plate and is positioned in a plane parallel to the heat spreader plate.

84. (newly added) The apparatus as defined in claim 82 positioned in a case for the electronic device, the case including an opening therethrough for access between its

inner and outer surface and the chiller is positioned adjacent the opening such that the air can pass out the opening after moving through the fins.

85. (newly added) The apparatus as defined in claim 82, wherein said electronic device is a microprocessor comprising a die mounted in a package and the said hot portion is said non-active surface.

86. (newly added) The apparatus as defined in claim 84, wherein a passage is provided within said body through which said fluid may be circulated, said passage comprising a series of chambers separated by constrictions.

87. (newly added) The apparatus as defined in claim 82, further comprising a fan oriented to move air between said fins.

88. (newly added) The apparatus as defined in claim 87, further comprising a thermoelectric cooler having a cool face and a warm face when connected to a power source, said thermoelectric cooler interposed between said second fluid heat exchanger and said heat spreader plate so that said cool face is thermally coupled to said second fluid heat exchanger and said warm face is thermally coupled to said heat spreader plate.

89. (newly added) The apparatus as defined in claim 82, further comprising a second heat spreader plate thermally coupled to said second fluid heat exchanger; and a second stack of spaced-apart heat conductive fins, the second stack thermally coupled to said second heat spreader plate.

90. (newly added) The apparatus as defined in claim 89, wherein the second heat spreader plate includes a face which face is positioned in a parallel plane to the primary plane of the first heat spreader plate.

91. (newly added) The apparatus as defined in claim 89, wherein the second fluid heat exchanger is positioned substantially centrally between the extended lengths of the stacks of fins.
92. (newly added) The apparatus as defined in claim 89, wherein all of said fins are substantially parallel to each other.
93. (newly added) The apparatus as defined in claim 92, further comprising a fan oriented to blow air between all of said fins in a direction substantially parallel to said heat spreader plates.
94. (newly added) The apparatus as defined in claim 93, further comprising a cylindrical housing, wherein said second fluid heat exchanger, said heat spreader plates, and said fin stacks are mounted inside said housing.
95. (newly added) The apparatus as defined in claim 94, wherein the lengths of said fins are selected so that each extends to an interior wall defining said housing.
96. (newly added) The apparatus as defined in claim 94 wherein the cylindrical housing defines a long axis and the second fluid heat exchanger is positioned along the long axis.
97. (newly added) The apparatus as defined in claim 95, wherein each fin stack includes a base plate and is extruded as a unitary structure.
98. (newly added) The apparatus as defined in claim 95, wherein each heat spreader plate and associated fin stack is extruded as a unitary structure.
99. (newly added) The apparatus as defined in claim 89, further comprising two thermoelectric coolers, each having a cool face and a warm face when connected to a power source, each thermoelectric cooler interposed between said second fluid heat

exchanger and a discrete one of said heat spreader plates so that said cool face of each said thermoelectric cooler is thermally coupled to said second fluid heat exchanger and said warm face is thermally coupled to one of said heat spreader plates.

100. (newly added) A heat exchanger comprising:

a body having a portion capable of thermal coupling to a heat conductor;

a conduit through the body through which a heat exchanging fluid may be circulated so that heat can be transferred between the heat exchanging fluid and the body; and

a heat-conducting path between the conduit and the portion of said body,

the conduit defining a direction of fluid flow and including a series of chambers of circular cross section parallel to the fluid flow direction, the chambers separated by constrictions.

101. (newly added) The heat exchanger of claim 100 used to transfer heat from the heat exchanging fluid to the heat conductor.

102. (newly added) The heat exchanger of claim 100 used to transfer heat to the heat exchanging fluid from the heat conductor.

103. (newly added) The heat exchanger of claim 100, wherein each chamber includes a diameter and a central point at the center of its circular cross section and at least some of adjacent chambers are positioned with their central points spaced less than their diameter such that the constrictions are formed by overlapping chambers.

104. (newly added) The heat exchanger of claim 100, wherein each chamber includes a diameter and a central point at the center of its circular cross section and at least

some of adjacent chambers are positioned with their central points spaced more than their diameters and the constrictions are formed by openings therebetween.

105. (newly added) The heat exchanger of claim 100, wherein at least some chambers are formed as cylinders.

106. (newly added) The heat exchanger of claim 100, wherein at least some chambers are formed as spheres.

107. (newly added) The heat exchanger of claim 100, wherein the transition between chambers and constrictions is smooth.

108. (newly added) The heat exchanger of claim 100, wherein the body is formed as a one-part structure.

109. (newly added) The heat exchanger of claim 100, wherein the body includes a center block forming the chambers and a faceplate on either side of the center block to enclose the chambers.



In the Drawings:

Cancel the drawings presently on file and substitute therefore the enclosed set of drawings, which have been formally prepared.